

WHAT IS CLAIMED IS:

1. A nonaqueous electrolyte comprising a nonaqueous solvent and a solute dissolved in said nonaqueous solvent,

5            wherein said nonaqueous solvent contains a main solvent including 20 to 50% by volume of ethylene carbonate and 40 to 80% by volume of  $\gamma$ -butyrolactone and a third solvent including at least one kind of solvent selected from the group consisting of ethylene  
10           sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinylethylene carbonate.

2. A nonaqueous electrolyte secondary battery, comprising:

15           a case having a wall thickness not larger than 0.3 mm;

            a positive electrode provided in said case;

            a negative electrode provided in said case; and

            a nonaqueous electrolyte provided in said case and  
20           comprising a nonaqueous solvent containing ethylene carbonate and  $\gamma$ -butyrolactone and a solute dissolved in the nonaqueous solvent,

            wherein, when a charge-discharge cycle test satisfying conditions (A) to (D) given below is  
25           performed under an environment of 45°C, the capacity retention rate at 100-th charge-discharge cycle is at least 85% based on the discharge capacity in the first

charge-discharge cycle:

(A) for the charging, the constant current-constant voltage charging to 4.2V is performed for 3 hours under a current of 1C;

5 (B) the discharging is performed to 3V under a current of 1C;

(C) after the charging, the secondary battery is left to stand for 10 minutes, followed by performing the discharging; and

10 (D) after the discharging, the secondary battery is left to stand for 10 minutes, followed by performing the charging.

3. The nonaqueous electrolyte secondary battery according to claim 2, wherein the amount of said  
15 ethylene carbonate based on said nonaqueous solvent falls within a range of between 20% by weight and 50% by weight, and the amount of said  $\gamma$ -butyrolactone based on said nonaqueous electrolyte falls within a range of between 40% by weight and 80% by weight.

20 4. A nonaqueous electrolyte secondary battery comprising a case having a wall thickness not larger than 0.3 mm, a positive electrode provided in said case, a negative electrode provided in said case; and a nonaqueous electrolyte provided in said case and  
25 comprising a nonaqueous solvent and a solute dissolved in said nonaqueous solvent,

wherein said nonaqueous solvent contains a main

solvent including 20 to 50% by volume of ethylene carbonate and 40 to 80% by volume of  $\gamma$ -butyrolactone and a third solvent including at least one kind of solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinylethylene carbonate.

5. The nonaqueous electrolyte secondary battery according to claim 4, wherein said nonaqueous electrolyte is substantially in the form of a liquid or a gel.

6. The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is not larger than 5% by weight.

7. The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is not larger than 3% by weight in the case where said third solvent includes at least one kind of solvent selected from the group consisting of phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinylethylene carbonate.

8. The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is not larger than 1.5% by weight in the case where said third

solvent includes at least one kind of solvent selected from the group consisting of 2-methylfuran, furan, thiophene and catechol carbonate.

5 9. The nonaqueous electrolyte secondary battery according to claim 4, wherein the amount of said third solvent based on the nonaqueous solvent is not larger than 2% by weight in the case where said third solvent includes ethylene sulfite.

10 10. The nonaqueous electrolyte secondary battery according to claim 4, wherein said third solvent consists essentially of at least one kind of solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, catechol carbonate and vinyl ethylene carbonate.

15 11. The nonaqueous electrolyte secondary battery according to claim 4, wherein said third solvent further includes at least one kind of solvent selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl  
20 carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate, the amount of said third solvent based on the nonaqueous solvent is not larger than 5% by weight, and the amount of propylene carbonate based on the nonaqueous electrolyte  
25 is smaller than 2% by volume (including 0% by volume).

12. The nonaqueous electrolyte secondary battery according to claim 4, wherein said third solvent

further includes vinylene carbonate and at least one kind of solvent selected from the group consisting of propylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate, the amount of said third solvent based on the nonaqueous solvent is not larger than 5% by weight, and the amount of propylene carbonate based on the nonaqueous electrolyte is smaller than 2% by volume (including 0% by volume).

10        13. The nonaqueous electrolyte secondary battery according to claim 4, wherein said solute includes at least one lithium salt selected from the group consisting of  $\text{LiClO}_4$ ,  $\text{LiPF}_6$ ,  $\text{LiBF}_4$ ,  $\text{LiAsF}_6$ ,  $\text{LiCF}_3\text{SO}_3$ ,  $\text{LiN}(\text{CF}_3\text{SO}_2)_2$  and  $\text{LiN}(\text{C}_2\text{F}_5\text{SO}_2)_2$ .

15        14. The nonaqueous electrolyte secondary battery according to claim 4, wherein said negative electrode contains a carbonaceous material capable of absorbing-desorbing lithium ions.

20        15. The nonaqueous electrolyte secondary battery according to claim 14, wherein said carbonaceous material includes mesophase pitch based carbon fiber.

25        16. The nonaqueous electrolyte secondary battery according to claim 4, wherein said case is formed essentially of a metal plate, a metal film or a sheet including a resin layer.

17. A nonaqueous electrolyte secondary battery comprising a case having a wall thickness not larger

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than 0.3 mm, a positive electrode provided in said case,  
a negative electrode provided in said case, and a  
nonaqueous electrolyte layer arranged between said  
positive electrode and said negative electrode, and  
5 said nonaqueous electrolyte layer containing a  
nonaqueous electrolyte and a polymer capable of gelling  
said nonaqueous electrolyte,

wherein said nonaqueous electrolyte contains a  
nonaqueous solvent including a main solvent comprising  
10 20% to 50% by volume of ethylene carbonate and 40% to  
80% by volume of  $\gamma$ -butyrolactone and a third solvent  
comprising at least one kind of solvent selected from  
the group consisting of ethylene sulfite,  
phenylethylene carbonate, 2-methylfuran, furan,  
15 thiophene, catechol carbonate and vinylethylene  
carbonate.

18. The nonaqueous electrolyte secondary battery  
according to claim 17, wherein the amount of said third  
solvent based on the nonaqueous solvent is not larger  
20 than 5% by weight.

19. The nonaqueous electrolyte secondary battery  
according to claim 17, wherein the amount of said third  
solvent based on the nonaqueous solvent is not larger  
than 3% by weight in the case where said third solvent  
25 includes at least one kind of solvent selected from  
the group consisting of phenylethylene carbonate,  
2-methylfuran, furan, thiophene, catechol carbonate and

vinylethylene carbonate.

20. The nonaqueous electrolyte secondary battery according to claim 17, wherein the amount of said third solvent based on the nonaqueous solvent is not larger  
5 than 1.5% by weight in the case where said third solvent includes at least one kind of solvent selected from the group consisting of 2-methylfuran, furan, thiophene and catechol carbonate.

21. The nonaqueous electrolyte secondary battery  
10 according to claim 17, wherein the amount of said third solvent based on the nonaqueous solvent is not larger than 2% by weight in the case where said third solvent includes ethylene sulfite.

22. The nonaqueous electrolyte secondary battery  
15 according to claim 17, wherein said third solvent consists essentially of at least one kind of solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, catechol carbonate and vinylethylene carbonate.

20 23. The nonaqueous electrolyte secondary battery according to claim 17, wherein said third solvent further includes at least one kind of solvent selected from the group consisting of propylene carbonate, vinylene carbonate, diethyl carbonate, dimethyl  
25 carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate, the amount of said third solvent based on the nonaqueous solvent

is not larger than 5% by weight, and the amount of propylene carbonate based on the nonaqueous solvent is smaller than 2% by volume (including 0% by volume).

24. The nonaqueous electrolyte secondary battery according to claim 17, wherein said third solvent further includes vinylene carbonate and at least one kind of solvent selected from the group consisting of propylene carbonate, diethyl carbonate, dimethyl carbonate, ethyl methyl carbonate,  $\gamma$ -valerolactone, methyl propionate and ethyl propionate, the amount of said third solvent based on the nonaqueous solvent is not larger than 5% by weight, and the amount of propylene carbonate based on the nonaqueous solvent is smaller than 2% by volume (including 0% by volume).

25. A nonaqueous electrolyte, comprising:

a nonaqueous solvent containing ethylene carbonate (EC),  $\gamma$ -butyrolactone (BL), and at least one third solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate and vinylethylene carbonate, the EC content falling within a range of 20 to 50% by volume based on the total amount of the EC and the BL, and the BL content falling within a range of 40 to 80% by volume based on the total amount of the EC and the BL; and

a solute dissolved in said nonaqueous solvent.

26. A nonaqueous electrolyte secondary battery,



comprising:

a case having a wall thickness not larger than  
0.3 mm;

a positive electrode provided in said case;

5 a negative electrode provided in said case; and

a nonaqueous electrolyte which is provided in said  
case and comprises a nonaqueous solvent and a solute  
dissolved in said nonaqueous solvent, said nonaqueous  
solvent containing ethylene carbonate (EC),

10  $\gamma$ -butyrolactone (BL), and at least one third solvent  
selected from the group consisting of ethylene sulfite,  
phenylethylene carbonate, 2-methylfuran, furan,  
thiophene, catechol carbonate and vinylethylene  
carbonate, the EC content falling within a range of 20  
15 to 50% by volume based on the total amount of the EC  
and the BL, and the BL content falling within a range  
of 40 to 80% by volume based on the total amount of the  
EC and the BL.

27. The nonaqueous electrolyte secondary battery  
20 according to claim 26, wherein said at least one third  
solvent is contained in an amount of 5% by weight or  
less based on the total amount of said nonaqueous  
solvent.

28. The nonaqueous electrolyte secondary battery  
25 according to claim 26, wherein, when said at least one  
third solvent is formed of at least one solvent  
selected from the group consisting of phenylethylene

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carbonate, 2-methylfuran, furan, thiophene, catechol  
carbonate and vinylethylene carbonate, the mixing  
amount of said at least one third solvent is not larger  
than 3% by weight based on the total amount of said  
5 nonaqueous solvent.

29. The nonaqueous electrolyte secondary battery  
according to claim 26, wherein, when said at least one  
third solvent is formed of at least one solvent  
selected from the group consisting of 2-methylfuran,  
10 furan, thiophene, and catechol carbonate, the mixing  
amount of said at least one third solvent is not larger  
than 1.5% by weight based on the total amount of said  
nonaqueous solvent.

30. The nonaqueous electrolyte secondary battery  
15 according to claim 26, wherein, when ethylene sulfite  
is used as said at least one third solvent, the mixing  
amount of said at least one third solvent is not larger  
than 2% by weight based on the total amount of said  
nonaqueous solvent.

20 31. The nonaqueous electrolyte secondary battery  
according to claim 26, wherein said at least one third  
solvent is formed of at least one solvent selected from  
the group consisting of ethylene sulfite,  
phenylethylene carbonate, catechol carbonate and  
25 vinylethylene carbonate.

32. A nonaqueous electrolyte secondary battery,  
comprising:

a case having a wall thickness not larger than  
0.3 mm;

a positive electrode provided in said case;

a negative electrode provided in said case; and

5 a nonaqueous electrolyte layer which is arranged  
between said positive electrode and said negative  
electrode and comprises a nonaqueous electrolyte and  
a polymer for gelling said nonaqueous electrolyte, said  
nonaqueous electrolyte comprising a nonaqueous solvent  
10 containing ethylene carbonate (EC),  $\gamma$ -butyrolactone  
(BL), and at least one third solvent selected from the  
group consisting of ethylene sulfite, phenylethylene  
carbonate, 2-methylfuran, furan, thiophene, catechol  
carbonate and vinylethylene carbonate, the EC content  
15 falling within a range of 20 to 50% by volume based on  
the total amount of the EC and the BL, and the BL  
content falling within a range of 40 to 80% by volume  
based on the total amount of the EC and the BL.

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